# BIOLOGICAL BULLETIN

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OF THE

**Marine Biological Laboratory**

WOODS HOLE, MASS.

VOL. XXXV SEPTEMBER, 1918 No. 3

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All communications and manuscripts should be sent to the Managing Editor. the University of Chicago, Sept. 15th to June 15th, or Woods Hole, Mass., June 15th to Sept. 15th. Subscriptions and other matter should be addressed to the Biological Bulletin, 41 North Queen Street, Lancaster, Pa

*Vol. XXXV.* *September, 1918.* *No. 3*

# BIOLOGICAL BULLETIN

## THE MARINE BIOLOGICAL LABORATORY

TWENTIETH REPORT; FOR THE YEAR 1917

THIRTIETH YEAR

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## II. ACT OF INCORPORATION

No. 3170.

COMMONWEALTH OF MASSACHUSETTS

**Be It Known,** That whereas Alpheus Hyatt, William Sanford Stevens, William T. Sedgwick, Edward G. Gardiner, Susan Minns, Charles Sedgwick Minot, Samuel Wells, William G. Farlow, Anna D. Phillips and B. H. Van Vleck have associated themselves with the intention of forming a Corporation under the name of the Marine Biological Laboratory, for the purpose of establishing and maintaining

a laboratory or station for scientific study and investigation, and a school for instruction in biology and natural history, and have complied with the provisions of the statutes of this Commonwealth in such case made and provided, as appears from the certificate of the President, Treasurer, and Trustees of said Corporation, duly approved by the Commissioner of Corporations, and recorded in this office;

*Now, therefore*, I, HENRY B. PIERCE, Secretary of the Commonwealth of Massachusetts, *do hereby certify* that said A. Hyatt, W. S. Stevens, W. T. Sedgwick, E. G. Gardiner, S. Minns, C. S. Minot, S. Wells, W. G. Farlow, A. D. Phillips, and B. H. Van Vleck, their associates and successors, are legally organized and established as, and are hereby made, an existing Corporation, under the name of the MARINE BIOLOGICAL LABORATORY, with the powers, rights, and privileges, and subject to the limitations, duties, and restrictions, which by law appertain thereto.

*Witness* my official signature hereunto subscribed, and the seal of the Commonwealth of Massachusetts hereunto affixed, this twentieth day of March, in the year of our LORD ONE THOUSAND, EIGHT HUNDRED and EIGHTY-EIGHT. HENRY B. PIERCE,

[SEAL.] *Secretary of the Commonwealth.*

## III. BY-LAWS OF THE CORPORATION OF THE MARINE BIOLOGICAL LABORATORY

I. The annual meeting of the members shall be held on the second Tuesday in August, at the Laboratory, in Woods Hole, Mass., at 12 o'clock noon, in each year, and at such meeting the members shall choose by ballot a Treasurer and a Clerk, who shall be, *ex officio*, members of the Board of Trustees, and Trustees as hereinafter provided. At the annual meeting to be held in 1897, not more than twenty-four Trustees shall be chosen, who shall be divided into four classes, to serve one, two, three, and four years, respectively, and thereafter not more than eight Trustees shall be chosen annually for the term of four years. These officers shall hold their respective offices until others are chosen and qualified in their stead. The Director and Assistant Director, who shall be chosen by the Trustees, shall also be Trustees, *ex officio*.

II. Special meetings of the members may be called by the Trustees, to be held in Boston or in Woods Hole at such time and place as may be designated.

III. The Clerk shall give notice of meetings of the members by publication in some daily newspaper published in Boston at least fifteen days before such meeting, and in case of a special meeting the notice shall state the purpose for which it is called.

IV. Twenty-five members shall constitute a quorum at any meeting.

V. The Trustees shall have the control and management of the affairs of the Corporation; they shall present a report of its condition at every annual meeting; they shall elect one of their number President and may choose such other officers and agents as they may think best; they may fix the compensation and define the duties of all the officers and agents; and may remove them, or any of them, except those chosen by the members, at any time; they may fill vacancies occurring in any manner in their own number or in any of the offices. They shall from time to time elect members to the Corporation upon such terms and conditions as they may think best.

VI. Meetings of the Trustees shall be called by the President, or by any two Trustees, and the Secretary shall give notice thereof by written or printed notice sent to each Trustee by mail, postpaid. Seven Trustees shall constitute a quorum for the transaction of business. The Board of Trustees shall have power to choose an Executive Committee from their own number, and to delegate to such Committee such of their own powers as they may deem expedient.

VII. The President shall annually appoint two Trustees, who shall constitute a committee on finance, to examine from time to time the books and accounts of the Treasurer, and to audit his accounts at the close of the year. No investments of the funds of the Corporation shall be made by the Treasurer except approved by the finance committee in writing.

VIII. The consent of every Trustee shall be necessary to dissolution of the Marine Biological Laboratory. In case of dissolution, the property shall be given to the Boston Society of Natural History, or some similar public institution, on such terms as may then be agreed upon.

IX. These By-Laws may be altered at any meeting of the Trustees, provided that the notice of such meeting shall state that an alteration of the By-Laws will be acted upon.

X. Any member in good standing may vote at any meeting, either in person or by proxy duly executed.

# IV. TREASURER'S REPORT

## MARINE BIOLOGICAL LABORATORY BALANCE SHEET, DECEMBER 31, 1917

*Assets*

| | | |
|---|---|---|
| Cash in bank | $3,222.92 | |
| Petty cash at Woods Hole | 200.00 | $ 3,422.92 |
| Accounts receivable | | 7,732.81 |
| Investments (Schedule I.) | $11,677.88 | |
| Investments, cash (Schedule II.) | 607.71 | 12,285.59 |
| Inventories (not available) | | ..... |
| Suspense | | 1.50 |
| Plant account (Schedule III.) | | |
| Land | $122,537.53 | |
| Buildings | 169,117.44 | |
| Equipment | 76,727.33 | |
| | $368,382.30 | |
| Less reserve for depreciation | 8,881.82 | 359,500.48 |
| | | $382,943.30 |

*Liabilities and Surplus*

| | | |
|---|---|---|
| Accounts payable | | $ 90.58 |
| Notes payable | $3,000.00 | |
| Trust funds | 9,285.59 | 12,285.59 |
| Mortgage on Gansett property | — | 16,409.82 |
| Balancing account | $301,577.72 | |
| (Last report) | | |
| Excess of income | 2,682.15 | |
| Crane special donation | 9,247.44 | |
| New property | 41,250.00 | |
| | $354,757.31 | |
| Less Woods Hole trust shares | 600.00 | 354,157.31 |
| | | $382,943.30 |

## MARINE BIOLOGICAL LABORATORY INCOME AND EXPENSE FOR YEAR ENDED DECEMBER 31, 1917

| | Expense | Income | Loss | Gain |
|---|---|---|---|---|
| Administrative expense | $ 7,367.87 | | $ 7,367.87 | |
| Bar Neck property expense | 154.79 | | 154.79 | |
| BIOLOGICAL BULLETIN and dues | 2,984.85 | $ 2,730.66 | 254.19 | |
| Boat department | 5,186.14 | | 5,186.14 | |
| Carpenter department | 637.55 | 123.03 | 514.52 | |
| Chemical department | 875.81 | | 875.81 | |
| Dormitory department | 1,516.69 | 2,168.77 | | $ 652.08 |
| Depreciation | 7,148.71 | | 7,148.71 | |

| | | | | |
|---|---|---|---|---|
| Fish trap | 830.04 | 1,441.77 | | 611.73 |
| Gansett property expense | 939.08 | | 939.08 | |
| Interest on notes payable | 150.00 | | 150.00 | |
| Instruction | 3,992.09 | 4,130.00 | | 137.91 |
| Lectures, philosophical | 100.00 | | 100.00 | |
| Lectures, evening | 65.00 | | 65.00 | |
| Library department | 2,503.62 | 25.00 | 2,478.62 | |
| Mess | 15,394.20 | 16,835.41 | | 1,441.21 |
| Maintenance, buildings and grounds | 3,222.66 | | 3,222.66 | |
| New laboratory expense | 1,847.40 | | 1,847.40 | |
| Newman cottage | 44.28 | 112.50 | | 68.22 |
| Pumping station expense | 286.75 | | 286.75 | |
| Research department | | 3,675.00 | | 3,675.00 |
| Sundry expense and income | 982.81 | 2,447.49 | | 1,464.68 |
| Supply department | 12,002.68 | 18,815.22 | | 6,812.54 |
| Truck expense | 1,148.65 | | 1,148.65 | |
| Special dormitory expense Dexter house | 372.03 | | 372.03 | |
| Total expense | $69,753.70 | $52,504.85 | $32,112.22 | $14,863.37 |
| Total income | 52,504.85 | | 14,863.37 | |
| Excess of expense | $17,248.85 | | $17,248.85 | |
| Bad accounts charged off | 69.00 | | | |
| | $17,317.85 | | | |
| Contribution by Mr. C. R. Crane. | 20,000.00 | | | |
| Excess carried to balancing account | $ 2,682.15 | | | |

## MARINE BIOLOGICAL LABORATORY INVESTMENTS (BOOK VALUES) DECEMBER 31, 1917

*Reserve Fund*

| | | |
|---|---|---|
| $300 Liberty Loan Bonds, 4s | $ 300.00 | |
| $3,000 American Telephone & Telegraph Company 4s (represented by receipts for same as collateral) | 2,921.25 | |
| $500 Western Telephone & Telegraph Company, 5s | 496.88 | |
| 6 shares American Smelting & Refining Company, Preferred (receipt on file) | 732.00 | |
| 8 shares General Electric Company | 972.05 | |
| 14 shares United Shoe Machinery Company, Preferred | 393.75 | |
| 5 shares Massachusetts Gas Companies, Preferred | 444.63 | $6,260.56 |

*Lucretia Crocker Fund*

| | | |
|---|---|---|
| $100 Liberty Loan Bond 4s | $ 100.00 | |
| 1/5 of $1,000 American Telephone & Telegraph Company 4s | 194.75 | |
| 18 shares Vermont & Massachusetts Railroad Company | 2,416.50 | |
| 1 share American Telephone & Telegraph Company | 125.03 | |
| 2 shares General Electric Company | 240.85 | |
| 1 share West End Street Railway Company | 83.00 | 3,160.13 |

*Library Fund*

| | | |
|---|---|---|
| $200 Liberty Loan Bond, 4s | 200.00 | |
| 4/5 of $1,000 American Telephone & Telegraph Company, 4s | 779.00 | |
| 3 shares American Telephone & Telegraph Company | 375.08 | |
| 1 share American Smelting & Refining Company, Preferred (receipt on file) | 122.00 | |
| 3 shares General Electric Company | 371.10 | |
| 5 shares United Shoe Machinery Company, Preferred | 140.63 | |
| 3 shares Massachusetts Gas Companies, Preferred | 269.38 | 2,257.19 |
| Total, Exhibit A | | $11,677.88 |

## MARINE BIOLOGICAL LABORATORY CASH RECEIPTS AND PAYMENTS ON ACCOUNT OF INVESTMENTS FOR THE YEAR ENDED DECEMBER 31, 1917

*Reserve Fund*

| | | |
|---|---|---|
| Cash on hand January 1, 1917 | | $266.20 |
| *Receipts:* | | |
| Interest on $3,000 American Telephone & Telegraph Company, 4 per cent. Bonds | 120.00 | |
| Interest on $500 Western Telephone & Telegraph Company, 5 per cent. Bonds | 21.88 | |
| Interest on Bank Balance | 16.04 | |
| Dividends on 6 shares American Smelting & Refining Company, Preferred | 42.00 | |
| Dividends on 8 shares General Electric Company | 64.00 | |
| Dividends on 8 shares General Electric Company Red Cross | 8.00 | |
| Dividends on 14 shares United Shoe Machinery Company, Preferred | 21.00 | |
| Dividends on 5 shares Massachusetts Gas Companies, Preferred | 20.00 | |
| | $579.12 | |
| *Payments:* | | |
| Purchase of $300 4 per cent. Liberty Loan Bonds | $300.00 | |
| Purchase 1/4 of $500 Western Telephone & Telegraph Company 5s | 124.22 | 424.22 |
| | | $154.90 |

*Lucretia Crocker Fund*

| | | |
|---|---|---|
| Cash on hand January 1, 1917 | | $294.04 |
| *Receipts:* | | |
| Interest on 1/5 of $1,000 American Telephone & Telegraph Company, 4 per cent. Bonds | 8.00 | |
| Dividends on 18 shares Vermont & Massachusetts Railway Company | 108.00 | |
| Dividends on 1 share American Telephone & Telegraph Company | 8.00 | |
| Dividends on 1 share West End Street Railway Company | 3.50 | |

| | | |
|---|---|---|
| Dividends on 2½ shares General Electric Company (part).. | 17.00 | |
| Dividends on 2½ shares General Electric Company Red Cross | 2.00 | |
| | $440.54 | |
| Sale of 1 share American Telephone & Telegraph Company Rights | 2.00 | |
| Sale of ½ share General Electric Company Stock | 83.00 | |
| | $525.57 | |
| *Payments:* | | |
| Purchase of $100 4 per cent. Liberty Loan Bonds. $100.00 | | |
| Paid for Scholarship | 50.00 | 150.00 |
| | | $375.57 |

*Library Fund*

| | | |
|---|---|---|
| Cash on hand January 1, 1917 | $118.30 | |
| *Receipts:* | | |
| Interest on 4/5 of $1,000 American Telephone & Telegraph Company 4 per cent. Bonds | 32.00 | |
| | $150.30 | |
| Interest on 1/4 of $500 Western Telephone & Telegraph Company, 5 per cent. Bonds | $ 3.12 | |
| Dividends on 3 shares American Telephone & Telegraph Co. | 24.00 | |
| Dividends on 1 share American Smelting & Refining Company Preferred | 7.00 | |
| Dividends on 2½ shares General Electric Company (part) | 23.00 | |
| Dividends on 2½ shares General Electric Company Red Cross | 3.00 | |
| Dividends on 5 shares United Shoe Machinery Company Preferred | 7.50 | |
| Dividends on 3 shares Massachusetts Gas Companies, Preferred | 12.00 | |
| | $229.92 | |
| Sale of 3 shares American Telephone & Telegraph Company Rights | 6.10 | |
| Sale of 1/4 of $500 Western Telephone and Telegraph Company, 5s | 124.22 | |
| | $360.24 | |
| *Payments:* | | |
| Purchase of $200 4 per cent. Liberty Loan Bonds. $200.00 | | |
| Purchase of ½ share General Electric Company Stock | 83.00 | 283.00 77.24 |
| Total, Exhibit A | | $607.71 |

## MARINE BIOLOGICAL LABORATORY SUMMARY OF INVENTORY OF LAND, BUILDINGS, AND EQUIPMENT FOR PERIOD ENDED DECEMBER 31, 1917

| | | |
|---|---|---|
| A. Land, January 1, 1917 | | $78,406.29 |
| Purchases, 1917— | | |
| Bar Neck property | $30,000.00 | |

| | | | |
|---|---|---|---|
| Woods Hole trust property | 7,750.00 | | |
| Permanent improvements | 6,381.24 | 44,131.24 | $122,537.53 |
| B. Buildings, January 1, 1917 | | 163,848.88 | |
| Woods Hole boathouse | $3,500.00 | | |
| Permanent improvements | 1,768.56 | 5,268.56 | 169,117.44 |
| C. Equipment, January 1, 1917 | | $73,303.36 | |
| Permanent improvements | | 3,423.97 | 76,727.33 |
| | | | $368,382.30 |

## Marine Biological Laboratory Depreciation Reserve

*Buildings*

| | | |
|---|---|---|
| Balance, January 1, 1917 | $3,276.96 | |
| 2 per cent. depreciation, 1917 | 3,312.35 | |
| | $6,589.31 | |
| Less upkeep charges | 3,092.05 | $3,497.26 |

*Equipment*

| | | |
|---|---|---|
| Balance, January 1, 1917 | $3,665.16 | |
| 5 per cent. depreciation, 1917 | 3,836.36 | |
| | $7,501.52 | |
| Less upkeep charges | 2,116.96 | 5,384.56 |
| Total reserve, Exhibit A | | $8,881.82 |

February 6, 1918.

Mr. D. Blakely Hoar,
161 Devonshire Street,
Boston.

*Dear Sir:* We have completed our audit of the accounts of the Marine Biological Laboratory for the year ended December 31, 1917, as kept both at your office in Boston and at Woods Hole, and report thereon in the accompanying exhibits and schedules:

Exhibit A—Balance-Sheet as of December 31, 1917.
B—Income-and-Expense for year ended December 31, 1917.

Schedule I—Investments (Book Values).
II—Cash Receipts and Payments on account of Investments.
III—Summary of Inventory of Land, Buildings and Equipment.
IV—Depreciation Reserve.

We certify that, subject to the comments herewith, the balance-sheet and income-and-expense statement shown in Exhibits A

and B are in accordance with the books and correct to the best of our knowledge and belief.

Very respectfully,
HARVEY S. CHASE & CO.,
*Certified Public Accountants.*

## V. LIBRARIAN'S REPORT

AUGUST 14, 1917

The continued growth of the library is shown by the following figures:

| | |
|---|---|
| Total accessions | 14,269 |
| Previously noted | 12,615 |
| Journals, serials, etc. | 334 |
| Books | 356 |
| Reprints | 964 |
| | 1,654 |

This shows the greatest gain, as compared with last year, in new books and reprints; about four times as many books and one third more reprints. More individuals have demonstrated interest in the library this year. The following must be noted especially:

Books have been received from authors as follows: Raymond Pearl, A. Petrunkevitch, W. E. Castle, James G. Needham, A. M. Reese, W. B. Scott, J. B. Henderson, Jacques Loeb, R. Goldschmidt, H. S. Pratt, A. S. & P. P. Calvert, A. H. R. Buller and J. E. Peabody.

The University of Chicago Press has given 6 volumes and the Cambridge Press 1 volume.

Miss Mathilde Koch presented 30 bound volumes and a collection of miscellaneous material, not yet catalogued; Dr. Knower 13 bound volumes and a series of reprints; Prof. S. F. Clarke his collection of papers on hydroids consisting of 10 bound volumes and over 300 reprints; Miss Alice W. Wilcox a file of *Science* and one of the *Popular Science Monthly*. Dr. W. B. Cannon sent 40 reprints of his own papers and those of his students; and Dr. Wagner two more installments of duplicates

from the Wisconsin Academy. The Redwood Library, Newport, R. I., sent two boxes of miscellaneous duplicates, from which we have secured several valuable papers.

About 25 volumes and 100 reprints have been secured by the exchange of duplicate material.

The following sets have been completed this year:

*Experiment Station Record,*
*Proc. Zoöl. Soc. France,*
*Chemical Abstracts.*

The assistant librarian has kept a constant watch for opportunities to secure desirable accessions, as was proposed last year when a special fund requested was set aside for this purpose. The good effects of an extensive preliminary study and correspondence to prepare for such enterprise are now seen. Of the $500 set aside for the purchase of second-hand books and periodicals, $342.60 has been expended and 251 volumes secured.

Important monographs by Weismann, Garbowski, Blochman and many other bargains were secured; a full set of Wallace and Huxley were added; 33 leather bound volumes of *Popular Science Monthly*, in perfect condition, were bought at 30 cents each.

89 volumes have been added to incomplete files by securing missing parts. In this way substantial progress has been possible toward making up deficiencies. This method of building in lost parts, now feasible for the first time, is as important as extension From now on desirable bargains are apt to appear in numbers, which will enable us to systematically follow up this campaign. This should be done!

The serials listed below were not on our shelves last year:

*Abstracts of Bacteriology,*
*Journal of Genetics,*
*Memoirs Zoöl. Soc. France,*
*Archives Russes d'Anat. d'Hist. et d'Embryol.,*
*Journ. Russe de Zoölogie, Revue Zoölogique Russe,*
*Chemical Abstracts.*
*Journal of Heredity.*

The last two journals have been secured by exchange with the BIOLOGICAL BULLETIN.

Miscellaneous gifts may be noted as follows: A photograph of

Professor Whitman, and a medallion of Maupas by Dr. Lillie; a panorama of the Scripps Institute for Biological Research was given by Dr. Ritter, and colored by Miss L. M. Wallace; a history and photographs of the Indiana University Biological Station has been prepared by Dr. Fernandus Payne and presented to the laboratory as part of our biological station exhibit—an excellent idea. Miss Dunn has given a map of Woods Hole in 1887, just before the establishment of the laboratory.

The Journal Fund and individual financial support, promised from year to year as explained in the report for last year, will be continued. Owing to exceptional conditions we shall not now make any further statement of subscriptions, beyond an acknowledgment to Drs. Just and Alfred G. Mayer for their contributions of $10 each. The payment of other amounts promised will enable us to continue the New Journal list. Miss Mary E. Collett gave $10 for the purchase of books on the biography of scientific men.

Two useful undertakings have been started this year: First, a duplication of text-books and monographs which are used in the classes. The extra set will be of great value to investigators. We shall be glad for assistance here. Second, we have extended the loan department, borrowing from and loaning to other libraries, even in the winter, and permitting students here to take out books not demanded by investigators—volumes on the theoretical aspects of the subject, evolution, biography, heredity, etc., have been in demand by a certain few of the students.

As this has been a rather dull year in library development, in as far as external efforts are concerned, it has been possible to do more work in cataloging. Miss Scott has added 5,000 new cards to the author list started in revised form in 1913; and 15,000 subject cards have been made to start a subject-catalogue to be made as complete as possible. It may take 50,000 cards to make this index representative, but the effort seems well worth-while, especially because of the lapses in foreign bibliographies. Several investigators have gone over the subject scheme and have made valuable suggestions; we are anxious for all the assistance obtainable in this enterprise.

# VI. THE DIRECTOR'S REPORT

JANUARY 1, 1918

TO THE TRUSTEES OF THE MARINE BIOLOGICAL LABORATORY:

*Gentlemen:* I beg to present herewith a report of the thirtieth session of the Marine Biological Laboratory covering the year 1917. Shortly after our country was forced by Germany into a state of war, the suggestion came from several sources that the use of the buildings and equipment of the Marine Biological Laboratory should be offered to the Navy Department for the duration of the war, owing to the evident strategic position of Woods Hole with reference to naval operations. After some consultation the Director decided to write Secretary Daniels offering to recommend to the Board of Trustees that the property and equipment of the Laboratory should be placed at the disposal of the Navy for the duration of the war. It seemed important that the matter should come before the Secretary of the Navy in such a way that he would not fail to recognize the significance of the scientific work that would be displaced. It was therefore arranged through one of our number that the letter should be presented personally to Secretary Daniels by one of the assistant secretaries of the War Department. This was accordingly done. Secretary Daniels returned his thanks for the offer and stated that on account of the importance of the scientific work being accomplished by the men at the Laboratory, he hesitated to accept it, and that the Navy would not take advantage of the offer except under the greatest military necessity, and would not disturb us during the approaching summer.

In the course of the summer it was decided by the Navy Department to subdivide the coast defence work of the Second Naval District with headquarters at Newport among a number of subdistricts or sections and to locate the headquarters of subdistrict A at Woods Hole. H. F. Emmons was placed in command of this section. In the early part of the summer the Director of the Laboratory had several conversations with Commander Emmons which resulted in an agreement to furnish board and lodging to as many members of his corps as was possible up to

September 15, and to recommend certain arrangements for the winter to our Board of Trustees meeting on August 14. At this meeting the Director reported the negotiations to the Board, which thereupon *voted* "that the principle underlying the correspondence between Commander Emmons and the Director is approved by the Board of Trustees and that the details regarding use by the Navy of the Laboratory buildings and equipment be referred to the Director and the Assistant Director with power."

In accordance with this vote a contract was drawn up between the Marine Biological Laboratory and the United States of America for the Navy Department, leasing without compensation the mess hall, laundry, kitchen and store house, the homestead, the lecture hall building, the yacht club and the Dexter House together with all necessary equipment from September 15, 1917, to May 15, 1918; inventories were attached. It was agreed that there should be compensation for all wear and tear of a damaging character, and that the Navy Department should pay for insurance and all expenses of occupancy. Provision was also made for supervision by the Laboratory of all alterations in buildings, restoration of original conditions as desired, and retention of heating appliances by the Laboratory.

In accordance with this contract the buildings named, with the exception of the Dexter House, which was not needed, are being occupied by the Navy Department.

The spirit of the dealings has been that we should render the greatest possible service to the Navy without prejudice to our work of investigation and instruction. With the expiration of the contract next May the question will arise how to correlate the needs of the Navy with our own demands for the session of 1918. It is clear that unforeseen circumstances may arise requiring emergency action, and it is therefore suggested that the Board should leave adequate discretion to the Directors for dealing with the situation up to the time of its next meeting.

We are proceeding with the usual arrangements for the next summer session believing that it is the duty of scientific men not called directly to war service to maintain their scientific activities. It was expected that the war would exert an unfavorable effect upon the Laboratory; to a certain extent this expectation has

been realized, though not to the extent that was anticipated. The total attendance of investigators and students at the Laboratory since 1913 has been: 1913, 191; 1914, 218; 1915, 242; 1916, 231; 1917, 212. If 1916 is used for reference the reduction in attendance was about 8 per cent., with reference to 1915 about 12½ per cent.; only about 3 per cent. less than 1914, and over 10 per cent. more than 1913. The decline since 1915 must be attributed primarily to war conditions. It must be anticipated that the decline will continue for the duration of the war.

Analyzing the figures of attendance a little farther the attendance of investigators was 129, the same as 1914 and 1916, but 8 less than 1915; the attendance of students was 83 or 19 less than in 1916. Many of the young men, who registered earlier in the year for courses, withdrew on account of military duties; the decrease of attendance of men in courses was 17, of women 2.

ATTENDANCE OF MEN AND WOMEN IN COURSES

| | 1917. | | 1916. | | 1915. | | 1914. | |
|---|---|---|---|---|---|---|---|---|
| | Men. | Women. | Men. | Women. | Men. | Women. | Men. | Women. |
| I. Zoölogy | 9 | 37 | 12 | 38 | 20 | 27 | 16 | 27 |
| II. Embryology | 6 | 10 | 14 | 12 | 18 | 19 | 10 | 11 |
| III. Physiology | 6 | 7 | 8 | 6 | 14 | 1 | 5 | 5 |
| IV. Botany | 3 | 5 | 7 | 5 | 2 | 4 | 10 | 5 |
| Total | 24 | 59 | 41 | 61 | 54 | 51 | 41 | 48 |

The number of subscribing institutions was 38 in 1917 as against 40 in 1916. The receipts from such institutions were $4,750 in 1917 as against $4,900 in 1916. The total receipts on account of tuition and investigation were $7,850 in 1917, $8,625 in 1916.

The charge for board at the mess was raised for the first time in thirty years on account of the increased cost of supplies; members of the Laboratory were charged $5.50 per week instead of $5.00. The rate was raised for those not members of the Laboratory to $8.00 per week. Contracts for all staple supplies were made in the winter. The net results were entirely satisfactory to the members and to the Laboratory and the season closed with a net surplus of $1,441.21, as compared with a loss of $101.52 last year. There will thus be a sufficient sum for

repairs and replacements for the coming season. Part of the better results for this year must be attributed to the war garden which occupied most of our vacant land and supplied a large quantity of fresh vegetables, and part to a larger percentage of boarders who paid the higher rate and remained later in the season, including members of the Woods Hole Naval Section.

In accordance with the vote of the Board of Trustees on December 29, 1916, the executive committee adopted regulations with reference to the development of the Gansett property and to sales and leaseholds of parts thereof. Roads have been surveyed through the property and partly built; about 1,000 feet of six-inch water main has been laid; a provisional plan of subdivision of the property into 63 lots has been adopted, prices fixed, and part of it has been accurately surveyed for registration with the land court of Massachusetts, in accordance with the blue print submitted. The sale of five lots to three parties has been negotiated for the sum of $5,235. It is also proposed to reserve from sale for the present certain parts of the property for possible construction by the Laboratory of cottages for rent. Mr. Crane has furnished $5,613.56 for this work of development. It is hoped that in the future the receipts from sales and leaseholds will carry the property completely.

In connection with the future development of this property, Mr. Crane has also purchased the Newman lot 100 × 60 feet with bungalow for the sum of $2,000 and presented it to the Laboratory.

We are farther and most deeply grateful to Mr. Crane for presentation to the Laboratory of the harbor property known as the Bar Neck Wharf, comprising 54,624.4 square feet with 355 feet of harbor frontage. This is a direct continuation of our present frontage on the harbor, and for Laboratory purposes undoubtedly the most valuable piece of real estate in Woods Hole. This property has been conveyed to the Laboratory and was accepted by the Board of Trustees at the summer meeting (1917) subject to a lease of forty years to the Bar Neck Corporation, with the provision, however, that they may be dispossessed at any time by vote of our Board of Trustees that the Laboratory requires the use of the property.

In accordance with the vote of the Board of Trustees last August a committee consisting of H. C. Bumpus, A. P. Mathews and F. R. Lillie has approved a plan for a tablet inscription in Bronze in memory of our first Director and has let the contract to Miss Frances Grimes of New York. It is hoped to place this in the vestibule of our new building before next summer.

Lists of the staff, of investigators and students, a tabular view of attendance, of subscribing institutions, of evening lectures and of members of the corporation are appended as parts of this report.

## I. THE STAFF

**1917**

FRANK R. LILLIE, DIRECTOR,
Professor of Embryology, and Chairman of the Department of Zoölogy, The University of Chicago.

GILMAN A. DREW, ASSISTANT DIRECTOR,
Marine Biological Laboratory.

### ZOÖLOGY

I. INVESTIGATION

GARY N. CALKINS.....Professor of Protozoölogy, Columbia University.
E. G. CONKLIN.....Professor of Zoölogy, Princeton University.
GILMAN A. DREW.....Assistant Director, Marine Biological Laboratory.
GEORGE LEFEVRE.....Professor of Zoölogy, The University of Missouri.
FRANK R. LILLIE.....Professor of Embryology, The University of Chicago.
C. E. MCCLUNG.....Professor of Zoölogy, University of Pennsylvania.
T. H. MORGAN.....Professor of Experimental Zoölogy, Columbia University.
E. B. WILSON.....Professor of Zoölogy, Columbia University.

II. INSTRUCTION

CASWELL GRAVE.....Associate Professor of Zoölogy, Johns Hopkins University.
W. C. ALLEE.....Professor of Biology, Lake Forest College.

ROBERT HALL BOWEN....Graduate Student, Columbia University.
W. J. KOSTIR.....Instructor in Zoölogy and Entomology, Ohio State University.
FRANCIS M. ROOT.....Bruce Fellow, Johns Hopkins University.
W. H. TALIAFERRO.....Graduate Student, Johns Hopkins University.
RAYMOND BINFORD.....Professor of Zoölogy, Earlham College.

### EMBRYOLOGY

I. INVESTIGATION (See Zoölogy)

II. INSTRUCTION

WILLIAM E. KELLICOTT...Professor of Biology, Goucher College.
ROBERT A. BUDINGTON ...Professor of Zoölogy, Oberlin College.
CHARLES PACKARD.....Instructor in Zoölogy, Columbia University.
CHARLES G. ROGERS.....Professor of Zoölogy, Oberlin College.

### PHYSIOLOGY

I. INVESTIGATION

ALBERT P. MATHEWS.....Professor of Physiological Chemistry, The University of Chicago.
RALPH S. LILLIE.....Professor of Biology, Clark University.
HAROLD C. BRADLEY.....Assistant Professor of Physiological Chemistry, University of Wisconsin.

II. INSTRUCTION

RALPH S. LILLIE.....Professor of Biology, Clark University.
WALTER E. GARREY.....Professor of Physiology, Tulane University.
FRANK P. KNOWLTON.....Professor of Physiology, Syracuse University.
A. R. MOORE.....Professor of Physiology, Rutgers College.

### PHILOSOPHICAL ASPECTS OF BIOLOGY AND ALLIED SCIENCES

LECTURES

EDWARD G. SPAULDING....Professor of Philosophy, Princeton University.

### BOTANY

GEORGE T. MOORE.....Director, Missouri Botanical Garden and Professor of Botany, Washington University.

IVEY F. LEWIS.....Professor of Biology, University of Virginia.
CARL S. HOAR.....Instructor in charge of Botany, Williams College.
W. D. HOYT.....Associate Professor of Boilogy, Washington and Lee University.

**LIBRARY**

H. MCE. KNOWER.....Professor of Anatomy, University of Cincinnati, Librarian.
MARY E. SCOTT.....Assistant Librarian.

**CHEMICAL SUPPLIES**

OLIVER S. STRONG.....Assistant Professor of Neurology, College of Physicians and Surgeons, New York City, Chemist.

**SUPPLY DEPARTMENT**

G. M. GRAY.....Curator.
JOHN J. VEEDER.....Captain.
E. M. LEWIS.....Engineer.
A. W. LEATHERS.....Collector.
A. M. HILTON.....Collector.
F. G. GUSTAFSON...Collector in Botany.
EDNA M. WELLS....Clerk.
F. M. MACNAUGHT.....Business Manager.
HERBERT A. HILTON.....Superintendent of Buildings and Grounds.

## 2. INVESTIGATORS AND STUDENTS

1917

### ZOÖLOGY

**Independent Investigators**

ADDISON, WILLIAM H. F., Assistant Professor of Normal Histology and Embryology, University of Pennsylvania.
ALLEE, WARDER C., Professor of Biology, Lake Forest College.
ALLEN, EZRA, University of Pennsylvania.
ALTENBURG, EDGAR, Instructor in Biology, Rice Institute.
BIGELOW, ROBERT P., Associate Professor of Zoölogy, Massachusetts Institute of Technology.
BINFORD, RAYMOND, Professor of Zoölogy, Earlham College.
BRIDGES, CALVIN B., Research Assistant, Carnegie Institution.
BUDINGTON, ROBERT A., Professor of Zoölogy, Oberlin College.
CALKINS, GARY N., Professor of Protozoölogy, Columbia University.
CAROTHERS, E. ELEANOR, Assistant in Zoölogy, University of Pennsylvania.
CARVER, GAIL L., Professor of Biology, Mercer University.
CHIDESTER, FLOYD E., Professor of Zoölogy, Rutgers College.

CLAPP, CORNELIA M., Professor Emeritus, Mount Holyoke College.
CONKLIN, EDWIN G., Professor of Biology, Princeton University.
COPELAND, MANTON, Professor of Biology, Bowdoin College.
DANCHAKOFF, MME. VERA, Assistant Professor in Anatomy, Columbia University.
DONALDSON, HENRY H., Professor of Neurology, Wistar Institute.
DREW, GILMAN A., Assistant Director, Marine Biological Laboratory, Woods Hole.
FORBES, WILLIAM T. M., 23 Trowbridge Road, Worcester, Mass.
GOLDFARB, A. J., Assistant Professor of Biology, College of the City of New York.
GOLDSCHMIDT, RICHARD, Kaiser Wilhelm Institut für Biologie.
GOODRICH, HUBERT B., Associate Professor of Zoölogy, Wesleyan University.
GOULD, HARLEY N., Assistant Professor, West Virginia University Medical School.
GRAVE, CASWELL, Associate Professor of Zoölogy, Johns Hopkins University.
GREGORY, LOUISE H., Assistant Professor of Zoölogy, Barnard College.
GROSS, ALFRED O., Assistant Professor of Zoölogy, Bowdoin College.
HANCE, ROBERT T., Assistant in Zoölogy, University of Pennsylvania.
HOGUE, MARY J., Instructor in Zoölogy, Wellesley College.
KELLICOTT, WILLIAM E., Professor of Biology, Goucher College.
KNOWER, HENRY MCE., Professor of Anatomy, University of Cincinnati.
LILLIE, FRANK R., Chairman Department of Zoölogy, University of Chicago.
MCCLUNG, CLARENCE E., Director of the Zoölogical Laboratory, University of Pennsylvania.
MALONE, EDWARD F., Associate Professor of Antaomy, University of Cincinnati.
MAST, SAMUEL O., Associate Professor of Zoölogy, Johns Hopkins University.
METZ, CHARLES W., Staff Member, Carnegie Institution of Washington.
MINER, ROY W., Associate Curator in Invertebrate Zoölogy, American Museum of Natural History.
MORGAN, THOMAS H., Professor of Experimental Zoölogy, Columbia University.
MULLER, HERMANN J., Instructor, Rice Institute.
NEAL, HERBERT V., Professor of Zoölogy, Tufts College.
OSBURN, RAYMOND C., Professor of Zoölogy, Ohio State University.
PACKARD, CHARLES, Instructor in Zoölogy, Columbia University.
PATTEN, WILLIAM, Professor of Biology, Dartmouth College.
PAYNE, FERNANDUS, Associate Professor of Zoölogy, Indiana University.
PEEBLES, FLORENCE, Professor of Biology, Sophie Newcomb Memorial College.
PLOUGH, HAROLD H., Instructor in Zoölogy, Amherst College.
RICE, EDWARD L., Professor of Zoölogy, Ohio Wesleyan University.
RICHARDS, A., Professor of Zöology, Wabash College.
ROGERS, CHARLES G., Professor of Comparative Physiology, Oberlin College.
ROOT, FRANCIS M., Instructor in Zoölogy, Johns Hopkins University.
SMITH, LUCY W., Instructor in Zoölogy, Mount Holyoke College.
SPAULDING, EDWARD G., Professor of Philosophy, Princeton University.
STOCKARD, CHARLES R., Professor of Anatomy, Cornell University.
STRONG, OLIVER S., Assistant Professor of Neurology, Columbia University.
STURTEVANT, ALFRED H., Research Assistant, Columbia University.
WALLACE, EDITH M., Research Assistant, Columbia University.
WARREN, HOWARD C., Professor of Psychology, Princeton University.
WEINSTEIN, ALEXANDER, Assistant in Zoölogy, Columbia University.
WIEMAN, HARRY L., Head of Dept. of Zoölogy, University of Cincinnati.
WILSON, CHARLIE W., Head of Biology Department, Mills College.

WILSON, EDMUND B., Professor of Zoölogy, Columbia University.
WOODWARD, ALVALYN E., Instructor, Simmons College.
YOUNG, ROBERT T., Professor of Zoölogy, University of North Dakota.
ZELENY, CHARLES, Professor of Zoölogy, University of Illinois.

**Beginning Investigators**

BLAKE, IRVING H., Instructor in Zoölogy, Syracuse University.
BOWEN, ROBERT H., Instructor in Invertebrate Zoölogy, Columbia University.
BROWN, ALBERT M., Columbia University.
CHARLTON, HARRY H., North Billerica, Mass.
DAVIES, I. J., Technician, Rice Institute.
FERNALD, HELEN E., Research Assistant, Columbia University.
GUNTHER, MAUDE C., Eastern High School, Washington, D. C.
HAYDEN, MARGARET A., 400 West 118th St., New York City.
HOPKINS, HOYT S., Student, Johns Hopkins University.
KOSTIR, W. J., Instructor in Zoölogy, Ohio State University.
LYNCH, CLARA J., Brooks Hall, New York City.
MAHR, ERNEST F., 227 Clarendon St., Syracuse, N. Y.
MONTGOMERY, PRISCILLA B., University of Pennsylvania.
MUDD, STUART, Student, Washington University Medical School.
OLSEN, I. E., American Museum of Natural History, New York City.
PARMENTER, CHARLES L., Assistant, University of Pennsylvania.
SAFIR, SHELLEY R., Teacher in Stuyvesant High School, New York City.
SHIMOTORI, SHOW, American Museum of Natural History.
STARK, MARY B., Graduate Student, Columbia University.
STARR, ISAAC, JR., University of Pennsylvania.
STRINGER, CAROLINE E., Head of Department of Natural Science, Omaha High School.
SWINGLE, WILBUR W., Instructor in Zoölogy, University of Kansas.
TALIAFERRO, WILLIAM H., University, Va.
THIEL, GEORGE A., Teaching Fellow, University of Minnesota.

## PHYSIOLOGY

**Independent Investigators**

ADLER, ISAAC, 401 West End Ave., New York City.
CHAMBERS, ROBERT, Instructor in Anatomy, Cornell University Medical College.
DUESBERG, JULES, Research Associate, Carnegie Institution.
EDWARDS, DAYTON J., Instructor in Physiology, College of City of New York.
GARREY, WALTER E., Professor of Physiology, Tulane University.
HARVEY, E. NEWTON, Assistant Professor of Physiology, Princeton University.
HARVEY, MRS. E. NEWTON, Princeton, N. J.
HOSKINS, ELMER R., Instructor in Anatomy, New York University.
HOSKINS, MRS. ELMER R., Instructor in Histology, New York University.
HYDE, IDA H., Professor of Physiology, University of Kansas.
JUST, ERNEST E., Professor of Physiology, Harvard University.
KNOWLTON, FRANK P., Professor of Physiology, Syracuse University.
LILLIE, RALPH S., Professor of Biology, Clark University.
LOEB, JACQUES, Head of Department of Experimental Biology, Rockefeller Institute for Medical Research.
LYON, ELIAS P., Professor of Physiology, University of Minnesota.

MATHEWS, A. P., Professor of Physiological Chemistry, University of Chicago.
MOORE, ARTHUR R., Professor of Physiology, Rutgers College.
MORGULIS, SERGIUS, Professor of Physiology, Creighton University, College of Medicine.
NORTHROP, JOHN H., Assistant, Rockefeller Institute for Medical Research.
PARKER, GEORGE H., Professor of Zoölogy, Harvard University.
PERLZWEIG, WILLIAM A., Assistant Professor of Biochemistry, Creighton University, College of Medicine.
REDFIELD, ALFRED C., Teaching Fellow in Physiology, Harvard Medical School.
RUDISCH, JULIUS, Consulting Physician, Mount Sinai Hospital, New York.

**Beginning Investigators**

ADLER, FRANCIS H., Student of Medicine, University of Pennsylvania.
BRIGHT, ELIZABETD M., Technician, University of Maine.
FRIZZELL, TOM P., Fellow in Biology, Rice Institute.
IRWIN, MARIAN, Graduate Student, Radcliffe College.
MOORE, MRS. ARTHUR R., Graduate Student, Rutgers College.
YOUNG, ELRID G., Demonstrator in Chemistry, McGill University.

**BOTANY**

**Independent Investigators**

DAVIS, BRADLEY M., Professor of Botany, University of Pennsylvania.
HOAR, CARL S., Instructor in Biology, Williams College.
HOYT, WILLIAM D., Associate Professor of Biology, Washington and Lee University.
LEWIS, IVEY F., Professor of Biology, University of Virginia.
LYMAN, GEORGE R., Department of Agriculture, Washington, D. C.
MOORE, GEORGE T., Director, Missouri Botanical Garden, St. Louis.
OSTERHOUT, W. J. V., Professor of Botany, Harvard University.
STOKEY, ALMA G., Professor of Botany, Mount Holyoke College.

**Beginning Investigators**

FURBER, JANE M., 769 Washington St., Brookline, Mass.
HAAS, ALBERT R., Harvard University.
RABER, ORAN L., Harvard University.
STOCKHAUSEN, REGINA E., Assistant in Botany, Mount Holyoke College.
YAMPOLSKY, CECIL, Professor of Biology, Toledo University.

# STUDENTS

**1917**

**BOTANY**

BISHOP, DELLA, Teacher, The Liggett School.
CLELAND, RALPH E., Graduate Student, University of Pennsylvania.
HENDERSON, MARGARET W., University of Pennsylvania.
KINNEAR, EUNICE A., Student, Oberlin College.
RUSSELL, ALICE M., Graduate Student, University of Pennsylvania.
TAYLOR, WILLIAM RANDOLPH, Fellow in Botany, University of Pennsylvania.
THOMAS, RUTH E., Teacher, East Boston High School, Boston, Mass.
WHITE, RICHARD P., Student, Dartmouth College.

## EMBRYOLOGY

ALLEN, HELEN J., Graduate Student, University of Cincinnati.
ARMSTRONG, NELLIE P., Student, Knox College.
BRISTOL, ELISABETH, Vassar College.
CLARK, DANA V., Knox College.
CARLSON, C. O., Professor of Biology, Doane College.
DIETRICH, BERTHA K., Teacher, Bushwick High School.
DONOVAN, STEPHEN M., Professor of Biology, St. Bonaventure's College.
GOSTENHOFER, DOROTHY M., Student, Columbia University.
HERRICK, RUTH, University of Chicago.
HINRICHS, MARIE A., Lake Forest College.
INGRAHAM, HELEN, Student, Knox College.
MCKENZIE, ROBERT A., Student, Rutgers College.
PROCTOR, HARRIET T., Student, Radcliffe College.
STOLL, NORMAN R., Graduate Assistant, University of Michigan.
WARREN, SHIELDS, Student, Boston University.
WHITING, HELEN B., Instructor in Biology, Brown University.

## PHYSIOLOGY

ASH, RACHEL, 4176 Leidy Ave., Philadelphia, Pa.
ASHMAN, RICHARD, Assistant in Zoölogy, Rutgers College.
BANUS, MARIO G., Rockefeller Institute.
BEYER, HENRY G., U. S. Navy, Retired.
GREENLEAF, WALTER J., Princeton University.
GRIFFITH, FRED R., JR., Associate Professor of Biology, Southern Methodist University.
HERMAN, WILLIAM, Student, Harvard Medical School.
INGALS, MARY G., Student, University of Chicago.
KNIGHT, MARY S., Student, University of Cincinnati.
LITTELL, ELIZABETH D., Head of Science Dept., Brearley School, New York City.
MARKS, PAULINE C., Radcliffe College.
STOKES, FRANCES B., Swarthmore College.
WEINSTEIN, FLORENCE, Student, Barnard College.

## ZOÖLOGY

ABT, ARTHUR F., Student, University of Chicago.
ARNOLD, EMILIE E., Western Reserve University.
BOURQUIN, HELEN, Agnes Scott College.
CHAMPLIN, ARETA L., Student, Mt. Holyoke College.
CLARK, MARTHA L., Student, Doane College.
COLEMAN, LAWRENCE V., Assistant in Peabody Museum, Yale University.
COLLINS, ANNA M., Student, Butler College.
CONKLIN, MARY, Student, Goucher College.
CROCKER, JOSEPHINE, Hunter College.
DANFORTH, RALPH E., East Jaffrey, N. H.
DAVY, MARY W., Goucher College.
ELLIOTT, MARGARET E., Student, Knox College.
FISKE, MILDRED, Laboratory Assistant at Wellesley College.
GIBBS, GRACE M., University of Maine.

GRAVES, LUCY E., Goucher College.
GREENLEAF, WILLIAM E., Graduate Student, Yale University.
GUTHRIE, MARY J., Assistant in Zoölogy, University of Missouri.
HARPER, ISABEL W., 36 Mercer St., Princeton, N. J.
HARVEY, LOIS F., Student, Oberlin College.
HIBBARD, HOPE, Assistant in Zoölogy, University of Missouri.
HOAGLAND, RUTH A., Assistant in Zoölogy, Vassar College.
HOSFORD, CAROLINE A., Doane College.
HUMPHREYS, MILDRED J., Student, Mount Holyoke College.
JACOBS, HELEN G., Student, Simmons College.
KRAFT, NETTIE E. H., Student, Carleton College.
MERRITT, OLIVE E., Hunter College.
MILLER, JEANNETTE, Student, Doane College.
MOORE, EMILY L., Student, Goucher College.
NAIRNE, MATHILDE A., Student, Sophie Newcomb College.
NICHOLS, HOPE, Student, Mount Holyoke College.
PARKER, MARY F., Student, Simmons College.
PICKELS, ESTHER E., Laboratory Assistant, Mount Holyoke College.
PIERCE, RUTH W., Student, Oberlin College.
RAYMOND, MARY, Sophie Newcomb College.
ROBBINS, HARRIET L., Teacher of Biology, Knox College.
ROEHM, HILDA E., Student, Wellesley College.
SCHILLER, ESTHER B., Student, Goucher College.
SEIBERT, FLORENCE B., Student, Goucher College.
SPONG, PHILIP, Student, Butler College.
STEWART, DOROTHY G., Assistant in Department of Zoölogy, Mount Holyoke College.
STOCKMAN, CHARLES C., 2D, Student, Massachusetts Institute of Technology.
STONE, LEON S., Yale University.
TAPPAN, VIVIAN, Student, Barnard College.
THORNDIKE, AUGUSTUS, JR., Student, Harvard University.
VRABEC, SETTI L., Student, Mount Holyoke College.
WILSON, IRA T., Student, Lake Forest University.

## 3. TABULAR VIEW OF ATTENDANCE

| | 1913 | 1914 | 1915 | 1916 | 1917 |
|---|---|---|---|---|---|
| INVESTIGATORS—Total | 122 | 129 | 137 | 129 | 129 |
| Independent: | | | | | |
| Zoölogy | 58 | 62 | 69 | 70 | 63 |
| Physiology | 17 | 22 | 20 | 23 | 23 |
| Botany | 11 | 10 | 6 | 7 | 8 |
| Under Instruction: | | | | | |
| Zoölogy | 21 | 31 | 36 | 25 | 24 |
| Physiology | 7 | 1 | 4 | 3 | 6 |
| Botany | 7 | 3 | 2 | 1 | 5 |

| | | | | | |
|---|---|---|---|---|---|
| STUDENTS—Total | 69 | 89 | 105 | 102 | 83 |
| Zoölogy | 33 | 43 | 47 | 50 | 46 |
| Embryology | 22 | 21 | 37 | 26 | 16 |
| Physiology | 8 | 10 | 15 | 14 | 13 |
| Botany | 7 | 15 | 6 | 12 | 8 |
| TOTAL ATTENDANCE | 191 | 218 | 242 | 231 | 212 |
| INSTITUTIONS REPRESENTED— | | | | | |
| Total | 80 | 77 | 79 | 73 | 77 |
| By investigators | 50 | 51 | 59 | 51 | 60 |
| By students | 41 | 47 | 42 | 45 | 36 |
| SCHOOLS AND ACADEMIES REPRESENTED. | | | | | |
| By investigators | 3 | 1 | 3 | 0 | 2 |
| By students | 6 | 5 | 9 | 3 | 5 |

## SUBSCRIBING INSTITUTIONS—1917

BARNARD COLLEGE
BOWDOIN COLLEGE
CARLETON COLLEGE
COLLEGE OF PHYSICIANS AND SURGEONS
COLUMBIA UNIVERSITY
CREIGHTON UNIVERSITY
DARTMOUTH COLLEGE
DOANE COLLEGE
ELSE SERINGHAUS SCHOLARSHIP, HUNTER COLLEGE, New York City
GOUCHER COLLEGE
HARVARD UNIVERSITY
JOHNS HOPKINS UNIVERSITY
KAISER WILHELM INSTITUT FÜR BIOLOGIE
LAKE FOREST COLLEGE
LUCRETIA CROCKER SCHOLARSHIP
MOUNT HOLYOKE COLLEGE
OBERLIN COLLEGE
PRINCETON UNIVERSITY, DEPT. OF BIOLOGY
PRINCETON UNIVERSITY, DEPT. OF PSYCHOLOGY
RADCLIFFE COLLEGE
RICE INSTITUTE
ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH
RUTGERS COLLEGE

Simmons College
Smith College
Sophie Newcomb College
University of Chicago
University of Cincinnati
University of Illinois
University of Kansas
University of Michigan
University of Missouri
University of Pennsylvania
University of Wisconsin
Vassar College
Wellesley College
Wistar Institute of Anatomy and Biology
Yale University

## 5. EVENING LECTURES, 1917

Tuesday, July 3,
Prof. G. H. Parker....."New Experimental Evidences on the Question of Hearing in Fishes."

Friday, July 6
Prof. T. H. Morgan....."The Factorial Treatment in Heredity."

Wednesday, July 11,
Dr. G. H. Clowes....."Surface Tension and Protoplasmic Permeability."

Friday, July 13,
Prof. William Patten....."The Creative Power of Co-operation."

Tuesday, July 17,
Dr. Charles R. Stockard....."Modification of Germ Cells by Alcohol."

Friday, July 20,
Dr. George T. Moore....."Some Phases of Applied Botany."

Tuesday, July 24,
Dr. Gilman A. Drew....."The Spermatophore of the Squid."

Friday, July 27,
Dr. C. E. McClung....."Reactions of Cellular Structures to Physical Agents."

Tuesday, July 31,
PROF. HOWARD C. WARREN....."The Investigation of Human Intelligence."
Friday, Aug. 3,
PROF. H. H. DONALDSON....."Post-Natal Growth of the Mammalian Nervous System."
Tuesday, Aug. 7,
DR. H. LANG....."Six Years in the Belgian Congo with Remarks on the Natural History and the Natives."
Friday, Aug. 10,
MR. WILLIAM LYMAN UNDERWOOD."A Strange Story of the North Woods."

## 6. MEMBERS OF THE CORPORATION

AUGUST, 1917

ABBOTT, PROF. J. F., Washington University, St. Louis, Mo.
ADDISON, DR. W. H. F., University of Pennsylvania Medical School, Philadelphia, Pa.
ALLEE, DR. W. C., Lake Forest College, Lake Forest, Ill.
ALLEN, PROF. EZRA, 125 Thompson Ave., Ardmore, Pa.
ALLYN, MISS HARRIET M., Hackett Medical College, Canton, China.
ALSBURG, DR. C. S., U. S. Dept. of Agriculture, Washington, D. C.

BAITSELL, DR. GEORGE A., Yale University, New Haven, Conn.
BAKER, MRS. L. D., 123 Chiswick Road, Boston, Mass.
BAKER, DR. E. H., 154 W. Randolph St., Chicago, Ill.
BANCROFT, PROF. F. W., Aloha Farm, Concord, Cal.
BARDEEN, PROF. C. R., University of Wisconsin, Madison, Wis.
BECKWITH, MISS CORA J., Vassar College, Poughkeepsie, N. Y.
BEHRE, MISS ELINOR H., University of Chicago, Chicago, Ill.
BEYER, DR. H. G., Stoneleigh Court, Washington, D. C.
BIGELOW, PROF. M. A., Teachers College, Columbia University, New York City.
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# A STUDY OF SOMATIC CHROMOSOMES.

## II. The Chromosomes in Embryos of *Epilachna borealis* and *Diabrotica vittata*.

W. E. HOY, Jr.,

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### *Epilachna borealis.*

The oögenesis of *Epilachna* has not been described. Miss Stevens ('06) briefly described the spermatogenesis of this beetle. There are 18 chromosomes in the spermatogonia. One of these chromosomes, the *y*, is extremely small, its mate, the *x*, is larger. In each plate there are 2 chromosomes noticeably larger than the others. In the first maturation division the *x*-chromosome passes undivided to one pole of the spindle, while the *y* passes to the other pole. The spermatozoa, then, differ in that one half contain a small *y*, and the other half a larger *x*. Each contains one large macrochromosome (autosome).

Although the oögonial divisions and the maturation of the egg have not been worked out, the anticipated result of fertilization would be two sorts of embryos with respect to their chromosome content, one with two *x*'s, and one with an *xy* combination. This expectation is fulfilled in the divisions of the embryonic cells, as I shall show. The stages of development studied were: (1) Late cleavage, and (2) shortening of the elongate embryo. In all about 60 plates have been recorded.

Figs. 1–4 are from embryos having the *xy* combination in their chromosome complexes, these being the smallest chromosomes in the plate. Fig. 1 is a late cleavage division figure and shows the same characteristic elongation of the chromosomes as was seen in the case of *Anasa* at a similar stage of development (Hoy, '16). Figs. 2 and 3 are from cerebral neuroblasts, and are both from the same individual. Fig. 4 is from an ectoderm cell in the thoracic region. It will be seen that in all these figures there are two macrochromosomes comparable to those

found in the spermatogonia. Again, in all the figures the small *y*-chromosome is very conspicuous. The *x*-chromosome is here undoubtedly the next smallest in size, since this chromosome has no homologous mate. All the chromosomes show the typical elongate and more or less slender form characteristic of the Coleoptera. There do not seem to be any special peculiarities shown by the seven pairs of mesochromosomes, ranging between the macrochromosome pair and the *xy* pair, other than that they fall into a graded series according to size.

Plates from embryos containing no very small *y*-chromosome, but apparently having the small *x*-chromosome paired, are shown in Figs. 5–8. All these figures again show the large pair of macrochromosomes, and a series of seven paired mesochromosomes graudally diminishing in size. In none of the figures is there a small rounded *y*-chromosome, but in its place there is another the size of the *x*-chromosome.

It has, therefore, been possible to demonstrate that in Epilachna, where the male has an *x*-*y* pair in the spermatogonial complex, the embryos fall into two classes as regards their chromosome content, one class containing an *xy* pair, and the other 2 *x*'s.

RECORD OF COUNTS OF CHROMOSOMES IN *Epilachna*.

STAGE I.

*Cleavage Mitoses. xy Type.*

| Embryo. | No. of Chromosomes. | No. of Counts. |
|---|---|---|
| 1 | 18 | 1 |
| 2 | 18 | 8 |
| 3 | 18 | 2 |
| 4 | 18 | 1 |
| 5 | 18 | 2 |
| 6 | 18 | 2 |
| | | Total....16 |

*Cleavage Mitoses. 2x Type.*

| Embryo. | No. of Chromosomes. | No. of Counts. |
|---|---|---|
| 1 | 18 | 1 |
| 2 | 18 | 2 |
| 3 | 18 | 1 |
| 4 | 18 | 1 |
| 5 | 18 | 1 |
| 6 | 18 | 3 |
| | | Total.... 9 |

STAGE II.

*Shortening of the Elongate Embryo, xy type.*

| Embryo. | No. of Chromosomes in Hypodermis. | No. of Counts. | No. of Chromosomes in Neuroblast. | No. of Counts. | No. of Chromosomes in Mesoderm. | No. of Counts. |
|---|---|---|---|---|---|---|
| 1 | 18 | 1 | | | | |
| 2 | | | | | 18 | 1 |
| 3 | | | 18 | 1 | | |
| 4 | | | 18 | 1 | | |
| 5 | 18 | 1 | | | | |
| 6 | | | 18 | 3 | | |
| 7 | 18 | 2 | | | | |
| 8 | | | 18 | 2 | | |
| 9 | | | 18 | 1 | | |
| 10 | | | 18 | 2 | | |
| | | Total 4 | | Total 10 | | Total 1 |

*2x Type.*

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | 18 | 3 | | | | |
| 2 | 18 | 1 | | | 18 | 1 |
| 3 | | | 18 | 2 | 18 | 1 |
| 4 | | | | | 18 | 2 |
| 5 | 18 | 1 | | | | |
| 6 | | | | | 18 | 1 |
| 7 | | | 18 | 1 | | |
| 8 | | | 18 | 1 | | |
| 9 | | | 18 | 3 | | |
| 10 | | | 18 | 1 | | |
| | | Total 5 | | Total 8 | | Total 5 |

*Diabrotica vittata.*

Miss Stevens ('08) reports 21 chromosomes "of various sizes and shapes" in the spermatogonia of this species. Her figure shows one large macrochromosome pair. If arranged in a paired series graded in size, the unpaired *x*-chromosome would apparently be placed about ninth, followed by two pairs of smaller chromosomes. In the first maturation division the *x*-chromosome moves undivided to one pole of the spindle, giving them two classes of secondary spermatocytes. Of the resulting spermatozoa, one half contain an *x*-chromosome, and one half do not.

The second maturation of the egg was reported in a paper preliminary to this (Hoy, '14). Eleven chromosomes enter the female pronucleus. Fig. 12 shows the chromosomes of the first maturation division. There are eleven, each of them appearing

as a tetrad. They are clearly of different sizes, though the same size differences, such as appear in the spermatogonia, can not be observed.

Accordingly, two classes of embryos would be expected as the result of the fertilization, one containing 21, and the other 22 chromosomes in the embryonic cells. These differences have been observed and are shown in Figs. 9–11.

Figs. 9 and 10 are of the 21 chromosome type and are from the same embryo, corresponding in development to the stage of 3 of *Epilachna*. Fig. 11 is from an ectoderm cell of a late blastoderm stage of the 22 chromosome type. In all these figures one pair of chromosomes is much larger than any of the others. With the exception of the ninth chromosome in Figs. 9 and 10, all the other chromosomes form a paired series graded in size. In Fig. 11 there is no unpaired chromosome.

## Conclusions.

1. The developing eggs and embryos of *Epilachna borealis* fall into two classes in respect to their chromatin content, one containing an *xy* combination, and the other an *xx* combination of sex chromosomes in all the cells of the body which have been examined, the former corresponding to the chromosomes of the spermatogonia, the latter probably to those of the oögonia. The same size relations are maintained in all the chromosome groups of one type.

2. Two types of chromosome groups are found in embryos of *Diabrotica vittata*, one with 21 chromosomes, corresponding to the spermatogonial chromosomes and one with 22, presumably homologous with those of the oögonia. In each of these types the chromosomes do not vary in number and form in different tissue cells which have been studied.

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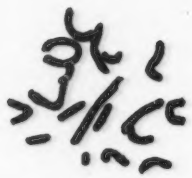
## Explanation of Plate I.

*Epilachna xy Type.*

Fig. 1. Cleavage.
Fig. 2. Neuroblast.
Fig. 3. Neuroblast.
Fig. 4. Ectoderm.

1



2

3

4

## Explanation of Plate II.

*Epilachna xx Type.*

Fig. 5. Cleavage.
Fig. 6. Neuroblast.
Fig. 7. Neuroblast.
Fig. 8. Ectoderm.

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## Explanation of Plate III.

*Diabrotica.*

Fig. 9. Ectoderm, 21 chromosomes.
Fig. 10. Neuroblast, 21 chromosomes.
Fig. 11. Ectoderm, 22 chromosomes.
Fig. 12. Tetrads of first maturation division of the egg.

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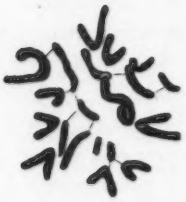

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# ON THE INTERSTITIAL CELLS OF THE TESTICLE IN DIDELPHYS.

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I completed a short time ago a study of the seminal cells of *Didelphys*, to appear (1919) in Contributions to Embryology, published by the Carnegie Institution of Washington, in a memorial volume dedicated to the late Professor Franklin P. Mall. While making that investigation I was struck by the large number of interstitial cells present in the testicle of the opossum, and, upon closer observation, by the complexity of their structure. I therefore determined to undertake a study of these cells.

The material upon which it was based consisted of nine animals. Five were full grown, a sixth exhibited all stages of spermiogenesis except the very last—*i. e.*, the formation of the spiral filament at the expense of the chondriosomes—and the remaining three were in a much less advanced stage of development. Fragments of the testicle were fixed in the following fluids: Hermann's, Ramon y Cajal's mixture of formalin and uranium nitrate (1912), Bouin's, Flemming's, Altmann's, Meves', Benda's, Regaud's, acetic sublimate and saturated sublimate. Two adult animals were sacrificed in order to study the living cells, and were injected with a solution of janus-green (1–10,000 in 0.85 per cent. salt solution). I am greatly indebted to Professor E. V. Cowdry for his help in carrying out these experiments.

Of the above mentioned reagents Benda's, Meves', Regaud's and Altmann's fluids were used for the purpose of fixing the chondriosomes. To stain these bodies iron-hematoxylin, Benda's and Altmann's methods, and a combination of acid fuchsin and methylgreen were employed. Ramon y Cajal's mixture of formalin and uranium-nitrate was applied in order to bring into evidence the apparatus of Golgi. The best preparations were

obtained by leaving the pieces in the fixative for 9 hours, in the silver nitrate 37 hours, and in the developer 14 hours. Instead of other complicated procedures, at the suggestion of Professor Cowdry I used the following method in the treatment of the sections: The slides were first immersed in 0.1 per cent. gold chloride for 2–3 hours; then in 5 per cent. hyposulphite 20–30 minutes. The results were excellent. Probably any nuclear dye could be used as a counterstain. I resorted to Ehrlich's hematoxylin, safranin, and methyl green (Cowdry, 1916), which in a concentration of one half per cent., applied for 30–60 seconds, gives a very sharp contrast to the black color of the apparatus and the pale background. For reasons to be made clear later on, special methods (Mallory's, safranin-light green, and a combination of Congo red, iron-hematoxylin and light green) had to be used for staining the connective tissue. In the application of these, especially of the latter method, Professor Van der Stricht kindly gave me the benefit of his wide experience. It may be worth while to state in passing that Mallory's method gives just as good if not better results after fixation with Flemming's fluid (modifications of Benda and of Meves included) as after sublimate or similar fixatives.

Concerning the structure of the interstitial cells in the opossum, I find in the literature only two short notes; one by Whitehead (1908), the other by Jordan (1911). Whitehead states that these cells contain no fat. Jordan represents the mitotic division of the interstitial cells and mentions their chondriosomes. Data on the structure of interstitial cells in other mammals, on the other hand, are abundant and will be referred to when occasion arises.

In accord with the description of a number of authors, notably Reinke (1896), Lenhossek (1897), Bouin and Ancel (1903), and Winiwarter (1912, 1), I found both single and double-nucleated interstitial cells (Figs. 2 and 7), although the latter are of far less frequent occurrence. Most of the nuclei show a marked depression on one side (Figs. 1, 3, 5, 9 and 10); only in material fixed with Regaud's fluid is this peculiarity of structure not visible, probably because the nuclei swell somewhat in this fixative. The process of formation of the double nuclei has not

been observed but is probably amitosis. Perhaps the nuclear depression just mentioned may be considered as an indication of direct division, but it must be stated that the number of cells in which this was noted greatly exceeded the number of binucleated cells. Mitotic division of the interstitial cells in the opossum, although observed occasionally, is rare. Jordan (1911, Fig. 7) has mentioned it.

The structure of the groundsubstance of the protoplasm varies considerably after the different fixatives. After all reagents that preserve the chondriosomes it appears homogeneous and exhibits a remarkable affinity for a number of dyes. In preparations made after Benda's method it stains intensely with sulfalizarin. Acid fuchsin is retained by it so tenaciously that the seminal epithelium usually has to be almost entirely unstained in order to obtain the proper grade of differentiation in the interstitial cells. Mulon (1911, 1 and 2) describes in the cells of the cortical suprarenal, in the corpora lutea and in the interstitial cells of the ovary, an amorphous, siderophile or osmiophile substance which, he supposes, is formed by the coalescence of chondriosomes. This substance he considers as a secretion which accumulates in the cell and is finally eliminated in bulk. Athias (1911), however, believes in the presence of a diffuse lipoid formed at the expense of poorly preserved chondriosomes. It is possible that the diffuse substance observed in my material may be the product of secretion, as we shall later see, but it certainly has nothing to do with artificial or natural disaggregation of the chondriosomes, for these bodies appear well preserved within it.

Lenhossek (1897) was the first author to describe the centers of the interstitial cell. In man he describes a darker inner zone—an "endoplasm" which corresponds obviously to the idiosome,[1] although he was not able to demonstrate the presence of centrioles within it. These have been recently brought into evidence in human material by Winiwarter (1912, 1), who found them to be rod-shaped. In the interstitial cells of the cat Lenhossek undoubtedly saw both the idiosome and the centrioles. In the opossum I find that there exists in most of the interstitial cells,

[1] In future I shall adopt the spelling *idiosome*, as proposed by Regaud (1910), instead of *idiozome*, for the reasons assigned by that author.

in close proximity to the nucleus, a differentiation of the cytoplasm (Figs. 1, 2 and 8). This zone contains the centrioles of the resting cell and is undoubtedly to be considered as an idiosome. In contradistinction to what one observes in the seminal cells, the idiosome of the interstitial cells is not sharply delimited by a special cortical layer. It appears most clearly in material fixed with Bouin's fluid or with any reagent containing osmic acid. It is frequently found located in the nuclear depression, as Ballowitz (1898, 1900) observed it, but not always so (for instance, Fig. 1). While two centrioles exist in the cells provided with only one nucleus, I find, as did Winiwarter in human material, that binucleated cells have four centrioles, and in some cases these are obviously rod-shaped (Fig. 2).

The extreme results obtained for the apparatus of Golgi by the Ramon y Cajal method are illustrated in Figs. 3 and 4.[1] In the first, the apparatus appears as a dense reticulum, in the second the reticulum is much looser. Normally, the apparatus is concentrated at one pole of the nucleus; cases like the one represented in Fig. 4, in which one or two branches of the network extend to the opposite pole and surround the nucleus completely, are exceptional. The apparatus is found either in the nuclear depression or in another place (Fig. 3). It behaves in this respect like the idiosome, and consequently nothing definite can be said concerning the topographical relationship of these two bodies. Nothing, however, would seem to militate against the existence of a close relationship such as has been established for a large number of other cells (for literature, see Duesberg, 1914, 1919). Other investigations will probably help to solve the problem, the present one being, to the best of my knowledge, the first on the apparatus of Golgi in the interstitial cells of the testicle. Concerning the interstitial cells of the ovary, we have the data of Cattaneo (1914) and Kulesch (1914).

While the interstitial cells of the opossum contain little fat, it would not be correct to say, with Whitehead, that they contain none at all. As a matter of fact, while the number of fat droplets is usually small, it varies with each animal. In other mam-

[1] Another drawing of an interstitial cell in the testicle of the opossum, with the apparatus of Golgi, will appear in another paper (1919, Fig. 34).

mals (rat, guinea-pig, rabbit, dog and man) Ciaccio (1910) describes a number of granules and vesicles which, after fixation with his special methods, stain with Sudan. Ciaccio considers these bodies as formed by a lipoid substance which, in his opinion, has a great analogy to the substance of the chondriosomes. Although none of my material was fixed exactly according to Ciaccio's prescription, I applied his method of staining to material fixed in Regaud's fluid and subsequently kept in 3 per cent. bichromate for a week, a procedure which is similar to Ciaccio's method 1. The results were identical with those obtained from preparations fixed with reagents containing osmic acid; that is to say, Sudan apparently stained in red what would be stained black in osmic acid. This conclusion was reached through the study of the seminal epithelium, in which the fat droplets have a characteristic arrangement, rather than through the study of the interstitial cells in which no such regular arrangement exists.

Pigment, which has often been found in other mammals and quite lately in the woodchuck by Rasmussen (1917), does not appear to exist at all in the interstitial cells of the opossum. Crystalloids, on the other hand, are found in many cells and are of two types. So far, those described for the first time by Reinke (1896) are supposed to exist only in human material, although Mathieu (1898) mentions the presence of "filaments cristalloïdiens" in the interstitial cells of the testicle in the cat. The plates accompanying his paper, however, are by no means clear. In the opossum many interstitial cells contain bodies similar to Reinke's crystalloids, although smaller and not so abundant (Fig. 6). They appear most clearly after fixation with Benda's or Meves' fluid, and can be seen in all other material except that fixed with Regaud's reagent; after the application of Benda's method they usually stain in brown. These bodies are rather short and thick; their ends are not pointed but blunt. Frequently they appear to be formed of two substances—a darker peripheric, and a lighter central one. In most cases only one crystalloid is found in a cell; occasionally, however, their number is increased, although they are never so abundant as Reinke's crystalloids in man. Sometimes a large crystalloid

will appear to be split at one end. The resemblance of these bodies to the crystalloids of Reinke is accentuated by the fact that, in rare cases, they are found surrounded by a clear space, located in a sort of vacuole.

The second type is not quite so frequently noted as that just described. It is represented by what appear to be thin rods, pointed at both extremities, which vary considerably in length in the different cells. The shorter ones are usually straight, the larger ones curved. In most of the cells they are multiple (Fig. 5). These, too, are seen most clearly after fixation with Benda's fluid, but are preserved in other fixatives also. In Regaud's preparations, however, I was never able to find them. Similar bodies exist in the cells of Sertoli. If I were to venture a comparison it would be to liken them to the bodies described by Lubarsch in the human testicle under the name of *Charcot-Böttcher's crystals*. The so-called Lubarsch crystals are, as Lenhossek has pointed out, located in the spermatogonia, but there is in the seminal epithelium another form of crystalloids, also described by Lubarsch (the Charcot-Böttcher crystals), which are larger and are located in the cells of Sertoli. According to Montgomery (1911) and to Winiwarter (1912, 2), the two forms are in genetic relation. Montgomery, who unfortunately failed to compare his observations with those of previous authors, described them in the "antepenultimate spermatogonia" of man as "rods," and came to the interesting conclusion, corroborated by Winiwarter (1912, 2), that "the presence of the rod determines the line of the Sertoli cell" (p. 368). Crystalloids have also been found in the Sertoli cells of the pig by Bouin and Ancel (1903, Fig. 11) and possibly in the cat by Hague (1914). I did not see anything resembling the numerous small crystalloids described by Lenhossek (p. 68, Figs. 2, 3 and 4), which correspond, in my opinion, to Winiwarter's (1912, 1) "grains riziformes."

The chondriosomes of the interstitial cells in mammals have been seen by Jordan (1911), Winiwarter (1912, 1), and Rasmussen (1917). As stated above, Jordan merely mentions their presence in the opossum. Winiwarter gives a longer account of these bodies in man, where he finds both granules and rods. Rasmussen describes in the woodchuck small granules, "the only

thing of a mitochondrial character that could be demonstrated in the interstitial cell at any time," a description which is rather unsatisfactory. My own observations show that the chondriosomes are exceedingly numerous and that they are mostly rods, short and curved. They are crowded into several heaps, some of which are often seen in close proximity to the nucleus. Fig. 7, drawn from a preparation fixed and stained after Benda, gives what should be considered their natural aspect, as they appear exactly alike in teased preparations after injection of janus-green. It is surprising how easily the interstitial cells take up the vital dye, in contradistinction to the seminal cells, which it is very difficult to stain in vivo: the reason for this difference is obviously the presence of a sheath of connective tissue around the seminiferous tubule. After fixation in Regaud's fluid the appearance is not altered; it must be stated, however, that after the action of that fluid, which has a great power of penetration, the chondriosomes can be well preserved all through the piece, while in Benda's material they are well fixed only in a very thin layer of tissue, at the periphery. The chondriosomes seem to be especially labile in the interstitial cells. As usual, the figures of deformation are, in the first stages, granules and vesicles. Of other forms, which I am led to consider as related to the chondriosomes, I shall speak later.

Winiwarter (1912, 1) mentions the existence of transitional forms between the chondriosomes and the crystals, but does not conclude definitely in favor of a genetic relationship. As an argument in favor of such a relationship one could bring into the field the following observations of that author: In the fetus chondriosomes only are present in the interstitial cells, the other elements appearing afterward. I regret to say that I have no information to offer on this point.

In all my material, except when again fixed with Regaud's fluid, cells are found, which contain a number of granules. These granules can be stained by different methods. I am strongly inclined to consider them as a secretion product, a question which will be taken up again shortly. As stated, these granules are not constant nor are they very abundant in one cell: not to be compared with the bulky masses represented by Bouin and Ancel (1903) for instance, in Fig. 7 of their paper.

We come now to the description of a most interesting condition in these interstitial cells of the opossum, a condition which I noted first in preparations stained and fixed after Benda, where it is most conspicuous. It can be seen also, however, in other preparations, such as Flemming's, Meves', Hermann's and Bouin's. A substance, which sometimes appears granular, at other times amorphous, fills the intercellular spaces. Its quantity is variable; some interspaces show so little of it as to escape notice, others are widely dilated by the presence of large quantities of the substance, as shown in Fig. 13. It is most conspicuous in preparations made after Benda's method because it takes up avidly the crystal-violet, in striking contrast to the light-brown color of the background and of the nuclei. The same substance stains intensely with safranin and iron-hematoxylin; in the Mallory method it takes up the orange and is consequently rather inconspicuous.

A closer investigation shows that from these intercellular spaces processes penetrate into the cell-body (Figs. 12 and 13). While most of these processes look like the substance accumulated in the intercellular spaces, some have the sharp appearance of a more definite structure, such as laminæ of some sort, and my first supposition was that I had to do with processes of connective tissue penetrating into the cell-body, such as have been described for large nerve-cells. A study of preparations stained especially for the connective tissue failed, however, to substantiate this opinion. After Mallory's stain, for instance, I could not find any such process electively stained in blue. While the thinnest fibrils of connective tissue in the sheath of the vessels and the connective membrane of the seminiferous tubules gave a typical collagenous reaction, in the same preparations the intracellular processes always were stained in orange like the intercellular substance. As a matter of fact, the study of these preparations corroborates Lenhossek's description (p. 78). The interstitial cells lie in heaps or irregular rows separated by the larger vessels. It is quite exceptional to see a process of the connective sheath of these vessels penetrate into a group of interstitial cells. The cells are, as a rule, separated only by intercellular spaces, virtual or real, and perhaps also in certain

places by small capillaries. I conclude, therefore, that the intracellular processes are formed by the substance filling the intercellular spaces, a substance which, in my opinion, represents the product of secretion. If this interpretation be correct, as I believe it to be, here is a remarkable instance of a gland with internal secretion, in which the product of secretion can be followed, owing to its staining qualities, from within the cell into the passage of excretion. Favorable sections, like that represented in Fig. 13, carry one even a step farther and show the same product in a vessel.

What, then, is the real nature of these intracellular and intercellular spaces, and of these vessels with which the intercellular spaces seem to be in some way connected? The penetration of lymphatics into a cell, not to speak of the much discussed and very disputable conditions described by Adamkiewicz (1886, 1900), Browicz (1902, 1 and 2), Schäfer (1902, 1903), Schlater (1902) and others, has been repeatedly reported. At first Holmgren interpreted his trophospongium as such. Among the more recent observations I may mention those published by Ciaccio (1903), Felicine (1904), Kumita (1909) and Matsunaga (1909). The first three authors studied the suprarenal. Ciaccio, after the application of Golgi's method, and Felicine and Kumita, as a result of injections, come to the conclusion that there exists a pericellular net of capillaries which send processes into the cells. Matsunaga has published similar results after his study of the thyroid by the injection method. Kumita, however, wonders whether these intracellular processes are really vessels, or "ob sie nicht durch einen sekretorischen Zellzerfall zustande gekommen sind" (p. 325). This last hypothesis, however, in his opinion can hardly be reconciled with the fact that the injected mass never spreads over all the cell, and that the intracellular space has a definite shape, ending often in a swelling in the neighborhood of the nucleus. No matter what the interpretation may be in these cases, it appears to me that the intracellular processes in the interstitial cells of the opossum are not well defined canals of any kind—neither processes of lymphatics nor intracellular ducts. They are always exceedingly irregular in appearance and are never seen in an empty condition, but always

as processes of the intercellular substance. No structure, at least no visible structure, appears to be the substratum of these processes. They represent, in my opinion, something like the "sekretorischer Zerfall" supposed by Kumita, or the accumulation along certain lines, perhaps in connection with protoplasmic currents, of the product of secretion. Nor do the intercellular spaces represent capillaries. Their irregular shape and the fact that no endothelium seems to line them, show that they are, as I have called them so far, merely intercellular spaces which become more or less dilated according to the quantity of secretion which is accumulated in them. Finally, that the space into which this substance is poured is a capillary cannot be doubted, for it is lined with a well-recognizable endothelium. Whether, on the other hand, this capillary is a lymphatic or a bloodvessel is not so easy to tell, and must be decided by methods other than those employed by me. Nor do the bibliographic data give any definite clue. Regaud (1897), who has made a special study of the distribution of the lymphatics in the mammalian testicle, finds that it is exceedingly variable in the different species. He distinguishes three types: One in which the lymphatic net is exclusively peritesticular; another in which the lymphatics penetrate as far as the corpus Highmori and the interlobular septa; and a third, in which the lymphatics form a network around the seminiferous tubules. It may be worth while to determine sometime, in connection with the problem of the excretion from the interstitial cells, to which type the opossum belongs.

To sum up, the product of secretion is accumulated in the interstitial cell, then discharged into the intercellular spaces, and from there passes into the circulation. Although this is one of the clearest instances in which the secretion product of a gland with internal secretion actually could be followed from the glandular cell into the vascular system, owing probably to the favorable staining properties of the secretion product, there are similar observations in the literature. Reinke has already called attention to the common staining properties of his crystals and the testicular lymph, and concludes in favor of the passage of the substance of these crystals into the lymphatics. Lenhossek

mentions (p. 78) the presence of a coagulum into the "lymphatic spaces" of the human testicle, and Sénat (1900, p. 65) writes: "Chez tous les rats dont les testicules ont été examinés, environ une dizaine, C. Regaud a rencontré dans les espaces conjonctifs une substance particulière, évidemment coagulée par les réactifs. . . . Cette substance a les mêmes réactions colorantes que le contenu protoplasmique des cellules interstitielles. Elle forme des flaques, parfois très étendues, qui englobent ces cellules. Cette substance parait être le produit de secrétion des cellules interstitielles; peut-être résulte-t-elle de leur désintégration." Bouin and Ancel (1903) state: "Une fois gorgées de leur produit de secrétion, les cellules l'expulsent au dehors; aussi le retrouve-t-on en grande abondance dans les espaces laissés libres entre ces cellules. . . . De plus, on voit également de semblables formations dans les vaisseaux sanguins et lymphatiques" (p. 476).

Something similar was found by the same authors (1904) in their "cellules à granulations xanthiques;" that is to say, special interstitial cells which appear in the testicle of the horse fetus. Here, however, the process goes so far that after the excretion, "la cellule est réduite à son noyau et à une faible quantité de cytoplasme, jaune noirâtre après emploi de la méthode de Benda. Nous n'avons pu discerner si ces éléments étaient susceptibles de recommencer un nouveau cycle secrétoire ou s'ils disparaissent après la phase d'excrétion, à la manière des cellules glandulaires holocrines" (pages CXLIV–CXLV). Finally, Popoff (1909), describing the interstitial cells in a human fetus 14 cm. long, says (pp. 447–448): "Dans un grand nombre de cellules, on observe des formations vacuolaires, à contours précis, entourant partiellement le noyau ou occupant au sein du protoplasme une place quelconque. Le nombre, la forme et les dimensions de ces vacuoles sont des plus variables. Tantôt, elles se présentent sous formes de fentes étroites et allongées, à direction inconstante; tantôt c'est un petit canal irrégulièrement calibré, incurvé ou une lacune en forme de croissant diversement orientée. Des formations analogues, peut-être en communication avec les précédentes, se rencontrent encore entre les cellules. Le tissu interstitiel est traversé par un grand nombre de capillaires sanguins, dont quelques-uns ont à peine le diamètre d'un

globule rouge. Un examen attentif révèle un rapport étroit des capillaires avec les espaces intercellulaires."

Similar observations on other glands with internal secretion have been made, notably the following: Hultgren and Andersson (1899) describe the secretion products in the medullar part of the suprarenal in mammals as granules which are expelled into the bloodvessels (see pp. 268–269): "Dies geschieht entweder durch das Wandern der kleinen Körner durch die Wandung der Gefässe, wie dies besonders an den Venen beobachtet wird, oder, es wird das Endothel der Capillaren an gewissen Stellen zersprengt und die Zellen treten mit dem Gefässlumen in direkter Verbindung."

In this case the fate of the secretion product is very clearly shown. Colson (1910) finds in the same gland intercellular spaces filled with the substance secreted by the cells. Apparently the cell-bodies are, to a certain extent, liquified, since there appear to be no definite boundaries between cells and intercellular spaces. These spaces are, in Colson's opinion, the same that Kumita, as reported above, found in communication with the lymphatic system. Van der Stricht (1912), in the corpus luteum, finds also that the secretion product of the lutein cells is accumulated in the intercellular spaces; in some cases this intercellular space is an axial cavity around which the cells are oriented as in an epithelium.

Finally, there are within the interstitial cells certain very peculiar constituents, which are represented in Figs. 6, 9, 10, 11 and 13. They have the appearance of a sort of huge network. In a number of cells the meshes of this network are small and the trabeculæ are thin, while in others the meshes are wide and the trabeculæ quite thick. The extremes are shown in Figs. 9 and 11, but all stages of transition between these two types can be found; one of these is seen in Fig. 10. The resemblance of this network to some apparatuses of Golgi is indeed very striking, but the results obtained with the method of Ramon y Cajal, which have already been described, show that the apparatus of Golgi in these cells is something entirely different. There is also a certain resemblance to some of the trophospongia pictured by Holmgren (1904), a point which will

shortly be discussed. In most cases, it is quite apparent that this peculiar formation does not invade the entire cell-body, but leaves two parts free; first, a space located in the immediate neighborhood of the nucleus, which it is safe, I believe, to consider as corresponding to the idiosome; second, the periphery of the cell. There are, however, exceptions to the latter rule, as in a number of cases some trabeculæ are seen very close to the cell-boundary.

The question arises: is there any connection between this network and the intracellular accumulations of the secretion product? In many cases it would appear as though both formations were in continuity, and that consequently the network were merely an extension of the intracellular processes throughout the cell-body. I am, however, of a different opinion. To me the network is the product of a transformation of the chondriosomes under special conditions of imperfect preservation. I am perfectly aware that no such forms have been described heretofore. The only thing with which I can, to a certain extent, compare these structures are the chondriosomes in the seminal cells of Scolopendra cingulata as represented (in my opinion imperfectly preserved) by Bouin (1905) especially in his Figs. 13, 14 and 15. The basis for this interpretation is that this network is found only in material fixed with Benda's or Meves' fluid (after Altmann's fixation the interstitial cells kept the acid fuchsin with such tenacity that no definite conclusion could be reached), but only in the deeper parts of the pieces; that is, where the chondriosomes are not well preserved. It is not found in material fixed in Regaud's fluid, but I assume that, as the latter reagent penetrates better than those just mentioned, it never gives the chondriosomes a chance to produce such distorted figures. As a matter of fact, they are pretty well preserved all through the pieces, and the only modified forms that appear in that material are the vesicles—the well-known first stages of chondriolysis. On the other hand, the secretion product is preserved by a number of reagents which do not fix the chondriosomes. The staining reactions are also different and point toward the chondriosomal nature of the network. Generally speaking, the network is stained in purple after Benda's method, that is,

like the product of secretion (the very large networks, such as that represented in Fig. 11, may make exception and stain with alizarin); but if we stain with safranin, we find that the secretion product alone takes up the dye and stands out conspicuously. A second reason which argues in favor of my interpretation is the existence of all possible transition forms between the network and the first stages of chondriolysis. In the cell represented in Fig. 8 there are some of those vesicles which, as we know, result from the artificial fragmentation and swelling of the chondriosomes. There are present also some forked forms, which are probably produced by the confluence of the swollen chondriosomes, and give an indication of how a network can be built at the expense of the normal, independent chondriosomes. Again, although at times the network appeared to be connected with the intracellular accumulations of secretion, on closer examination no such connection could be actually established. Finally, there is a difference in the structure; the product of secretion usually appears granular, while the substance of the network is homogeneous.

As stated above, I consider this network as produced by the transformation of the chondriosomes, not by a natural process, as is well understood, but by an artificial one. Of any intervention on the part of the chondriosomes in the formation of the secretion product, an intervention which in a number of cases seems to me entirely plausible, nothing could be seen here. Under what form does the product of secretion of the interstitial cells make its appearance? I have mentioned the presence of granules that are preserved by a number of fixing reagents. These granules are certainly secreted by the cell, but in my opinion they are too scarce and inconstant to be considered as the forerunners, or at least the only forerunners, of the product of the cell. One must consequently admit that the bulk of the secretion makes its appearance in a diffuse or non-stainable form. I would suggest, without, however, being able to substantiate that opinion, that the product of secretion is represented by the substance which is responsible for the diffuse staining of the protoplasm, something like Mulon's osmiophile or siderophile substance. But there is no indication in this case, as Mulon states it, that

this substance be formed by the coalescence of the chondriosomes, nor that the elimination be accompanied by a partial destruction of the cell.

While the existence of these strangely deformed chondriosomes is perhaps not very interesting in itself, it calls the attention of the cytologist to the possibility of a confusion between different cellular structures. Regardless of whether or not my interpretation be correct, two things are evident: (1) That the network has nothing whatever to do with the apparatus of Golgi, as is shown after the application of Ramon y Cajal's method; (2) that it bears a remarkable resemblance to many of the structures described as the apparatus of Golgi. There is one instance in the literature in which the chondriosomes, after application of a silver method, have been mistaken for the Golgi's apparatus (the cartilage cell, by Pensa, 1901),[1] and it is possible that a similar error is also the basis for Monti's interpretation of this structure in the adult nerve-cell. According to that writer (1915), what was described in these cells as the apparatus of Golgi is identical with the chondriosomes. I have discussed her paper extensively in another place (1919). Having since discovered this network in the interstitial cells of the opossum I am inclined to believe that Monti has been misled by a similar appearance.

Another point which I feel should be touched upon in this connection is Holmgren's trophospongium theory. In its latest form this theory claims the existence in a tissue of two types of cells—the parenchymal cells and the trophocytes. The former are penetrated by processes of the trophocytes, processes which form the trophospongial net and become, under certain circumstances liquified, forming the "*Kanälchen des Trophospongiums.*" The rôle of the trophocytes is, as their name implies, a trophic one. While Holmgren himself has never published anything on the interstitial cells of the testicle, these are the only objects for which his theory has found whole-hearted support. In one paper Bouin and Ancel (1905, 1) describe, in the first generation of interstitial cells in the testicle of horse fetuses from 22 to 42 cm. long, a structure which is "l'homologue du trophosponge de

[1] Pensa himself later on (1913) acknowledged his mistake.

Holmgren" (p. 395). This trophospongium belongs to the diffuse type. It appears either as a canalicular network (p. 399), or as a solid network (p. 404), and the authors suppose that it is the "transformation substantielle de ce trophosponge qui donne naissance au réseau des canalicules du suc, selon la conception de Holmgren" (p. 404). In that paper Bouin and Ancel are quite reserved as to the existence of connections between this network and trophocytes, but they subscribe entirely to Holmgren's conception in a note published the same year (1905, 2), evidently written subsequent to the other. According to their description the young interstitial cells of the testicle of the horse are penetrated by processes of cells of connective tissue acting as trophocytes. These processes are later transformed into a system of canals which open at the periphery of the interstitial cells. In these later stages they still surround, but can no longer be followed within the interstitial cells.

Whether or not Bouin and Ancel are still upholding their view I do not know, but it should be pointed out that no mention of it, or of the "canalicules du suc" is made in Bouin's description of the interstitial cells of the testicle, in Prenant, Bouin and Maillart's Traité d'Histologie. I would call attention also to the fact that the only figure in the above mentioned papers (Fig. 3, 1905, 1) that shows anything like what the authors describe, in reality rather contradicts that description. This figure represents a group of interstitial cells containing something that resembles the "canalicules du suc"; but at the same time there is no trace of trophocytes, cells of connective tissue, or any connective tissue at all, between these cells, and consequently no indication of a connection between such cells and the canalicular apparatus. This is the crucial point. Aimé (1907) also has described in the interstitial cells of the ovary intracellular spaces whose existence is beyond doubt, but he states definitely: "Nous n'avons pas vu de relations entre ces canaux et les cellules conjonctives entourant les cellules interstitielles" (p. 121, Fig. 11). The first point I would dispute is the existence of the trophocytes, at least in the opossum. As stated above, in a heap or row of interstitial cells the cells themselves are not separated by connective tissue or cells of any kind. On the other hand, if

Bouin and Ancel met with intracellular accumulations of an unstainable product of secretion, or such deformed chondriosomes as I have described above, I can readily see, from my own observations, how they arrived at their interpretation.

Concerning variations in number, size or structure of the interstitial cells with the development of the testicle (the most recent investigations upon these points being those of Rasmussen, 1917), I have little to say. The only thing which I noted was that, in the youngest testicles preserved (those in which the process of spermatogenesis had just begun) the interstitial cells were smaller than in the adult.

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## EXPLANATION OF PLATES.

All figures were outlined with a Zeiss camera-lucida, at the level of the stage of the microscope. Lenses used: for Figs. 1–12, Zeiss apochr. immers. 2 mm. (ap. I, 40), in combination with ocular 12; for Fig. 13, Zeiss apochr. imm. 1 mm. 5 (ap. I, 30), and ocular 6. Artificial light (gas).

### Explanation of Plate I.

1. Interstitial cell with idiosome and 2 centrioles. Fixation and stain after Benda.

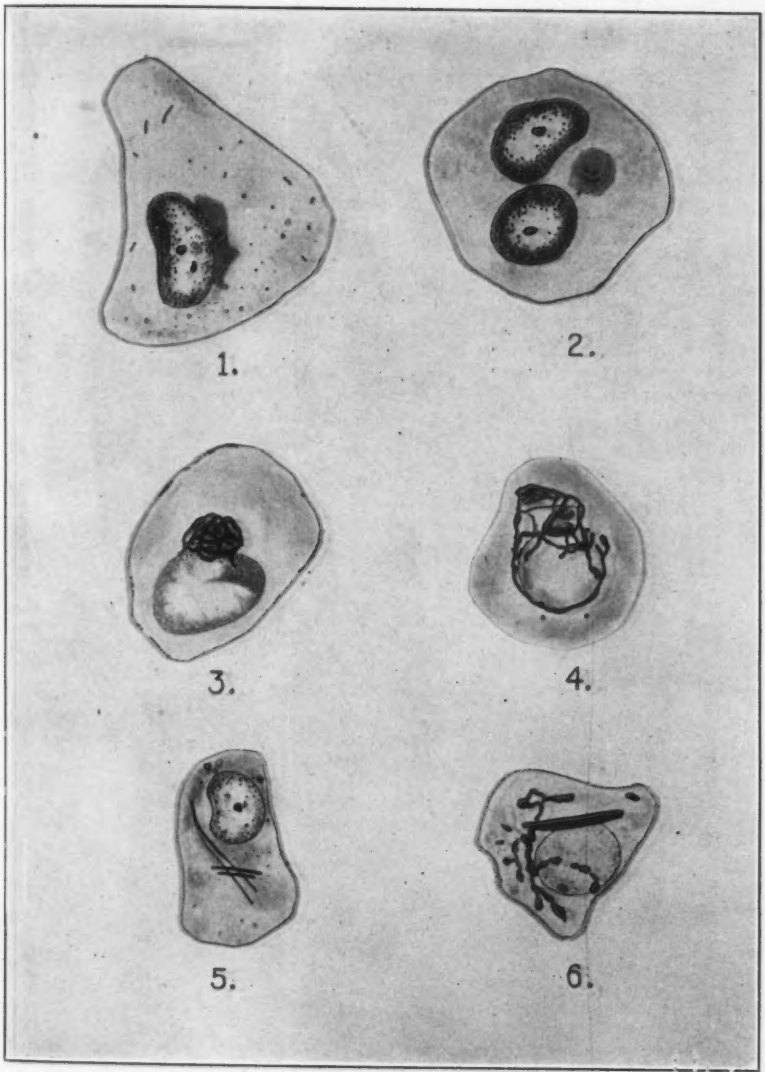
2. Interstitial cell with two nuclei, idiosome and 4 centrioles. Fixation and stain after Benda.

3. The apparatus of Golgi. Ramon y Cajal's method. Counterstain: Ehrlich's hematoxylin.

4. Another form of the apparatus of Golgi. Ramon y Cajal's method. Counterstain: methylgreen.

5. Interstitial cells with several crystals of the thin type. Fixation and stain after Benda.

6. A crystal of the thick type. Fixation and stain after Benda. The same cel shows part of the network made up of modified chondriosomes.

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EXPLANATION OF PLATE II.

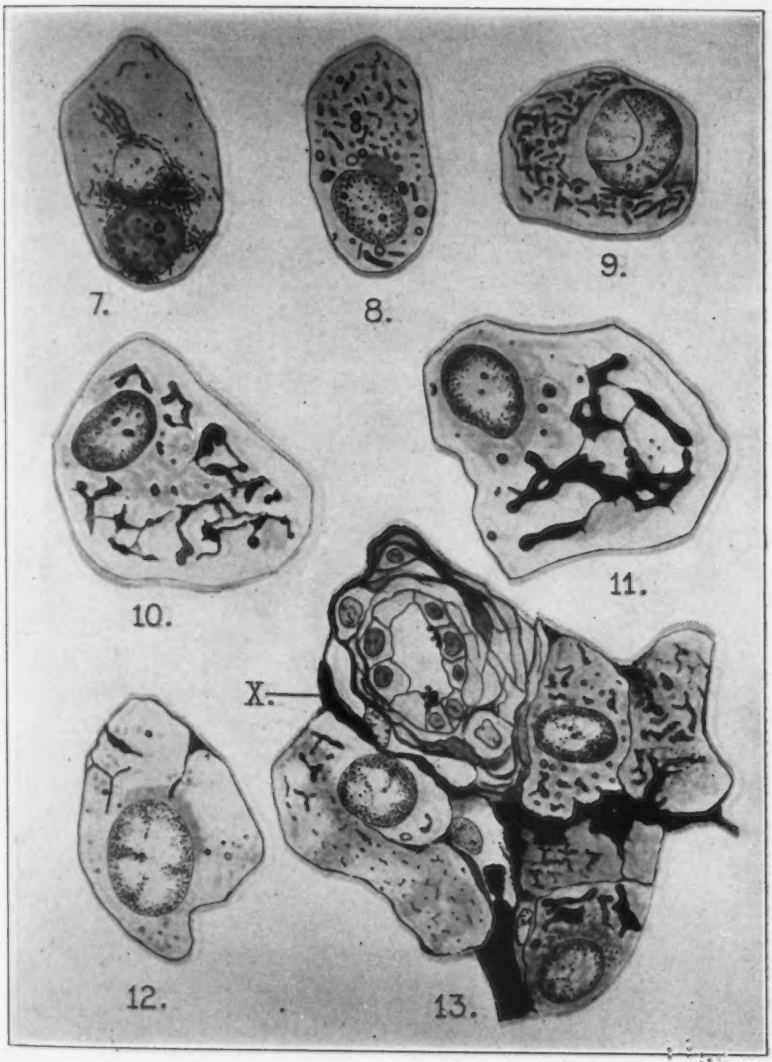
7. Binucleated cell with normal chondriosomes. Fixation and stain after Benda.

8. Cell with modified chondriosomes. Same fixation and stain.

9, 10 and 11. Different types of networks formed of modified chondriosomes. Same fixation and stain.

12. An interstitial cell with several exogenous processes. Same fixation and stain.

13. A group of interstitial cells, with intracellular and intercellular accumulation of secretion-product. The capillary, filled with the same product, extends, as the next section shows, up to the point marked X. Same fixation and stain.

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